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Floating solar power plant with asymmetrical concentrators

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(56) Related Art
US 4350143
US 5286305
US 5445177

EDITORIAL NOTE

APPLICATION NO. 71703/96

THIS SPECIFICATION DOES NOT CONTAIN AN ABSTRACT.

FLOATING SOLAR POWER PLANT WITH ASYMMETRICAL CONCENTRATORS

TECHNICAL FIELD

The invention relates to a circular solar platform floating on a shallow layer of water, rotatable about its vertical axis with concentrator channels arranged parallel to each other. The lower surfaces of the channels carry photovoltaic cells extending into the water layer. The concentrator channels are designed in such a way that they enclose air passages which, during hours without sunshine, are positioned in such a way that they run parallel to the direction of the wind.

PRIOR ART

Australian Patent 655 925 describes an optical system to bend, compress and concentrate solar rays onto photovoltaic cells as shown in figure 2, whereby the roof forming lens 16 and the photovoltaic cells are combined to a floating disk-shaped platform as shown in figure 1. The waste heat of the photovoltaic cells will be absorbed by water layer 9. The disadvantage of this design is that the waste heat from the photovoltaic cells, stored in the water layer 9, cannot be sufficiently dissipated to the ambient air.

SUMMARY OF THE INVENTION

It is an object of the present invention to overcome or substantially ameliorate the above disadvantage.

Accordingly, the present invention provides a solar power plant mounted on a circular platform rotatable about a vertical axis floating on a layer of water, the platform comprising a multitude of elongated concentrator channels with vertically extending walls which are covered by roof-forming linear lenses and which channels comprise photovoltaic cells mounted inside said channels at their lowest region, a turning device being provided, whereby during shunshine hours the platform turns so that the concentrator channels point to the azimuth of the sun while during non-sunshine hours the concentrator channels point to the direction of the wind, whereby the space outside the concentrator channels forms passages of triangular cross-section through which the wind can pass to dissipate the heat stored within the water layer.

DESCRIPTION OF THE DRAWINGS

Preferred forms of the present invention will now be described by way of example only with reference to the accompanying drawings, wherein:

Figure 1 shows the principle of optical tracking.

Figure 2 shows a portion of a solar power plant as described in the invention.

Figure 3 shows the path of rays within the linear lens.

Figure 4a shows a cross-section through a concentrator channel.

Figure 4b shows the end-section of a concentrator channel.

Figure 5a shows the pencil of rays in one extreme situation.

Figure 5b shows the pencil of rays in the opposite extreme situation.

Figure 6 shows a row of secondary concentrators.

DETAILED DESCRIPTION OF THE INVENTION

Figure 1 shows the symbolized path of the solar rays being refracted downwards by the upper layer 1, and being concentrated onto the photovoltaic cell 3 by the prism 2 of the second layer.

Figure 2 shows a portion of a floating solar platform in which the elongate concentrators 4 are shown in cross section. The water layer 8 is separated from the subsoil by a plastic membrane 5 which is surrounded by a circular wall 6. A central bearing 7 centrally locates the platform floating on the water layer 8. During sunshine hours the platform follows the sun's azimuth; during overcast and night hours a wind sensor causes the platform to turn such that the concentrators run parallel to the direction of the wind.

Figure 3 shows an enlarged cross-section of the linear lens. The upper layer 1 has a smooth upper surface 21. On its downward-facing side it has steps 18 which are divided into two optical boundary layers 19 and 20. The lower layer 22 has steps 23 on its upward facing boundary face with the same spacing as the steps 18. The edges of steps 23 are in contact with the separating line between the two optical boundary layers 19 and 20. Flanks 38, not penetrated by solar rays, run almost vertical. The downward-facing side of the lower layer 22 has sharply-angled prisms 24 running perpendicular to the steps 18 and 23. These prisms 24 concentrate the solar rays onto focal lines running parallel to prisms 24. Solar rays 25 undergo a total reflection on the right flanks 17 of prisms 24 in the sharply-angled section 11 shown in figure 5. From there they exit as rays 26 onto a focal line.

Figure 4a shows a vertical cross section through concentrator channel 4. The trough 41, 43, 42 whose wall 41 runs vertical, floats on water layer 48, whereby the bottom region 43 is slightly submerged in the water layer. The roof of the concentrator channel 4 is formed by parabolically-bent linear lenses 40. These lenses are divided into two sections; one section 11 has sharply-angled prisms which strongly bend the rays, and a second section 12, resembling a Fresnel lens which slightly bends the rays. The remaining triangular channel 44 acts as a wind passage through which the ambient air can flow, thus cooling the water layer 48 in which the waste heat of the photovoltaic cells has been stored. In areas in which the air is relatively free of dust the diagonal wall 46 can be eliminated. Wall 41 has a groove 47 which acts as a rail on which a maintenance cart can be run. Wall 41 and wall 42 form a channel 51 through which rain water can flow down into water layer 48.

Figure 4b shows the end section of a concentrator channel. The lower wall portion 55 is sealed to the bottom area 43 and the vertically extending wall sections from walls 41 and 42. Above this area a triangular wall 56 is inserted which prevents dust from entering the concentrator channels.

Figure 5a shows the pencil of rays 31 formed by the strongly bending section 11 when the sun's elevation is centrally located between the highest and the lowest elevation. The focal line 33 of the pencil of rays 31 then lies above focal line 32 of the pencil of rays 34 which is formed by the Fresnel prisms in section 12.

Figure 5b shows that the focal lines 32 and 33 for the lowest useable elevation and the maximum elevation have changed places compared to the situation described in figure 5a.

Figure 6 shows a secondary concentrator system to increase the concentration on the photovoltaic cells 60. These secondary concentrators 62 and 63 concentrate three- dimensionally, in the plane of the drawing as well as in the plane perpendicular to it. This minimizes the necessary surface of photovoltaic cells (60) as well as the cost of the cells. This reduction is possible because the waste heat of the photovoltaic cells (60) is dissipated through the metal wall of the troughs into the water layer (48). The secondary concentrators (62 and 63) are in contact with each other along line (64) so that the total concentrated radiation will reach the photovoltaic cells (60).

The claims defining the invention are as follows:

1. A solar power plant mounted on a circular platform rotatable about a vertical axis floating on a layer of water, the platform comprising a multitude of elongated concentrator channels with vertically extending walls which are covered by roof-forming linear lenses and which channels comprise photovoltaic cells mounted inside said channels at their lowest region, a turning device being provided, whereby during sunshine hours the platform turns so that the concentrator channels point to the azimuth of the sun while during non-sunshine hours the concentrator channels point to the direction of the wind, whereby the space outside the concentrator channels forms passages of triangular cross-section through which the wind can pass to dissipate the heat stored within the water layer.

2. Solar power plant according to claim 1, wherein the linear lenses are divided into two sections, wherein the strongly bending portion has prisms whose flanks which are not penetrated by the rays cause total reflection, while the slightly bending portion resembles Fresnel lenses.

3. Solar power plant according to claim 1, wherein the linear lens consists of two layers, the upper layer having prisms on its lower side, and the lower layer having prisms on its upper side running parallel to the prisms of the upper layer, while prisms on its lower side run perpendicular to said prisms on the upper layer.

4. Solar power plant according to claim 1, wherein concentrator channels are formed by a trough and a roof element, the lower portions of the axial ends of the trough being closed by wall elements so that the trough can float.

5. Solar power plant according to claim 1, wherein adjacent concentrator channels are placed at a small distance from each other forming a channel which allows rain water to flow down into the water layer.

6. Solar power plant according to claim 1, wherein each discrete photovoltaic cell forms a unit with a secondary concentrator, the secondary concentrators being contiguous to each other.

7. A solar power plant substantially as hereinbefore described with reference to the accompanying drawings.

Dated 8 June, 2000

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Patent Attorneys for the Applicant/Nominated Person

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Fig. 1

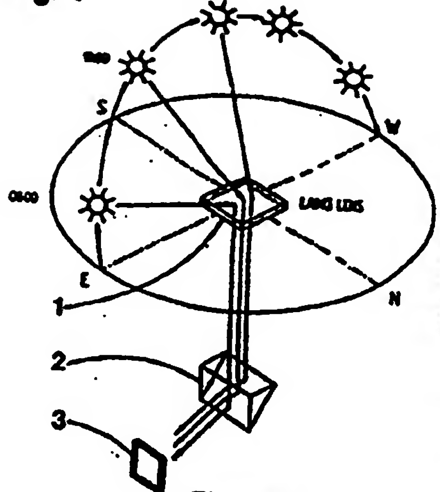


Fig. 2

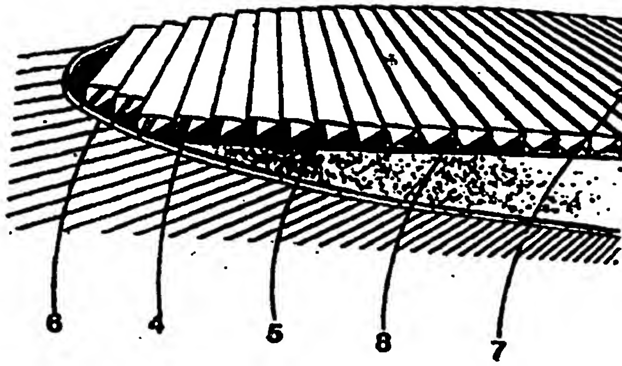


Figure 3

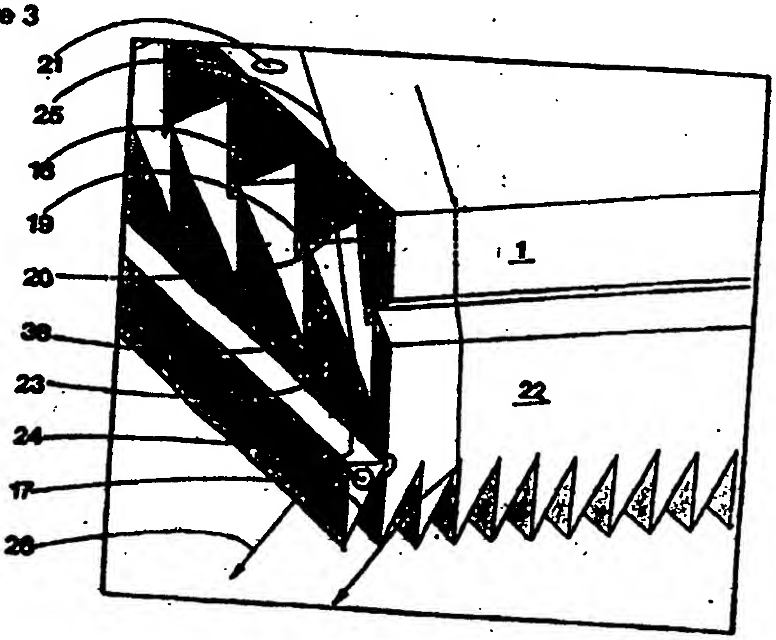


Figure 5a

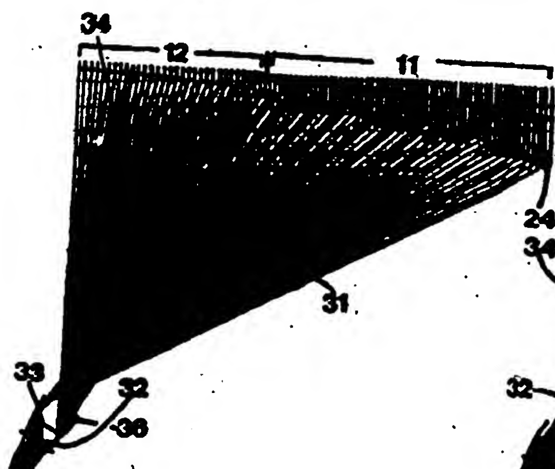
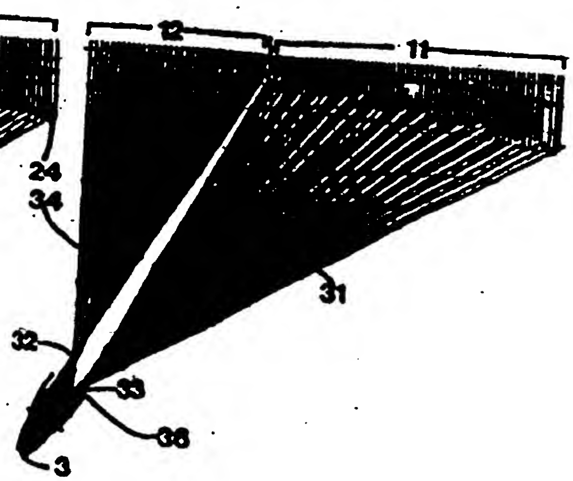


Figure 5b



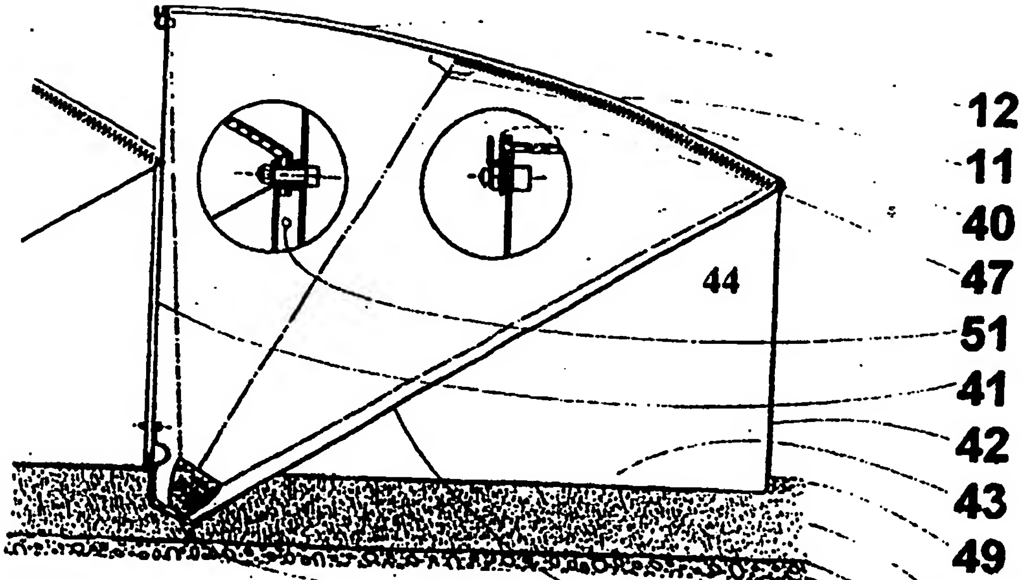


Figure 4a

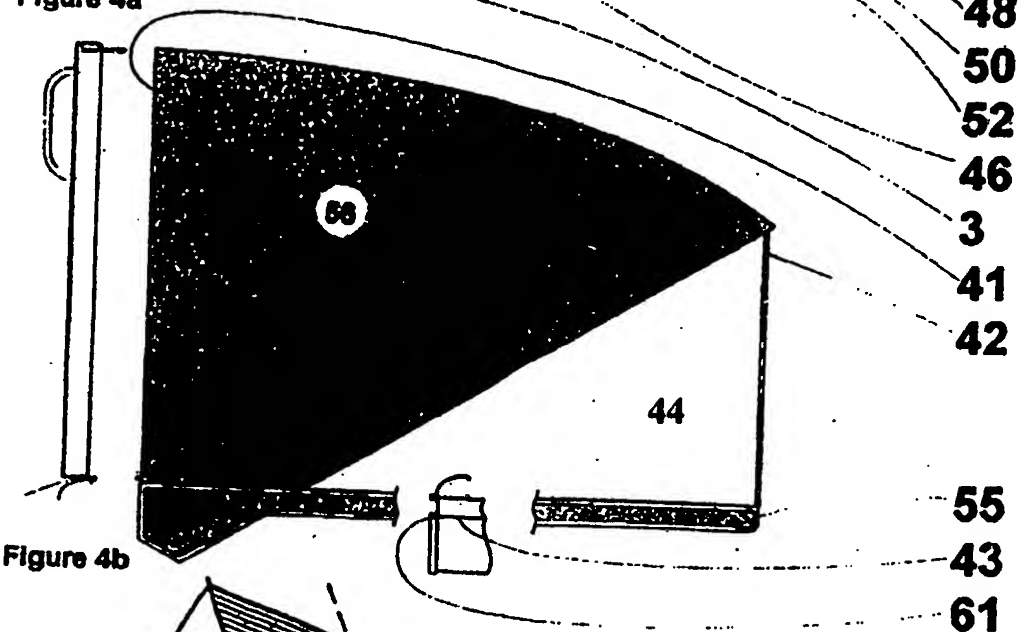


Figure 4b

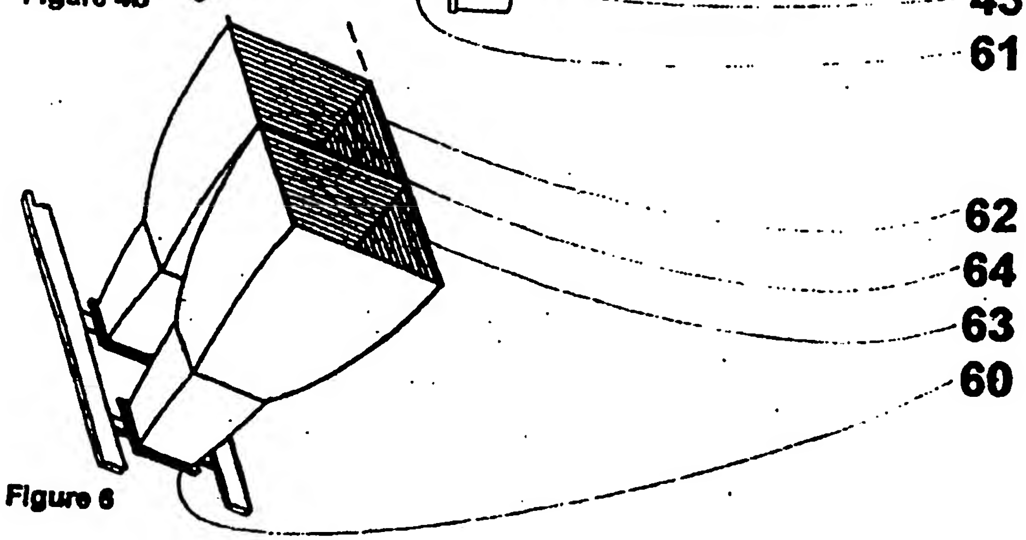


Figure 6